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ROCKY FORK RESERVOIR, HIGHLAND COUNTY, OHIO

PACIFIC NORTHWEST ENVIRONMENTAL RESEARCH
LABORATORY

PREPARED FOR
NATIONAL ENVIRONMENTAL RESEARCH CENTER

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

PACIFIC NORTHWEST ENVIRONMENTAL RESEARCH LABORATORY

An Associate Laboratory of the

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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Report

on

Rocky Fork Reservoir

Highland County

Ohio

EPA Region V

Working Paper No. 409

With the cooperation of the

Ohio Environmental Protection Agency

and the

Ohio National Guard

June, 1975

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Ohio Environmental Protection Agency for professional involvement, to the Ohio National Guard for conducting the tributary sampling phase of the Survey, and to those Ohio wastewater treatment plant operators who provided effluent samples and flow data.

Ned Williams, Director, and Tom Birch, Ken Carr, Larry Dietrick, Ron Havlice, Larry Korecko, Rod Mehlhop, Terry Wheeler, and John Youger, Ohio Environmental Protection Agency, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

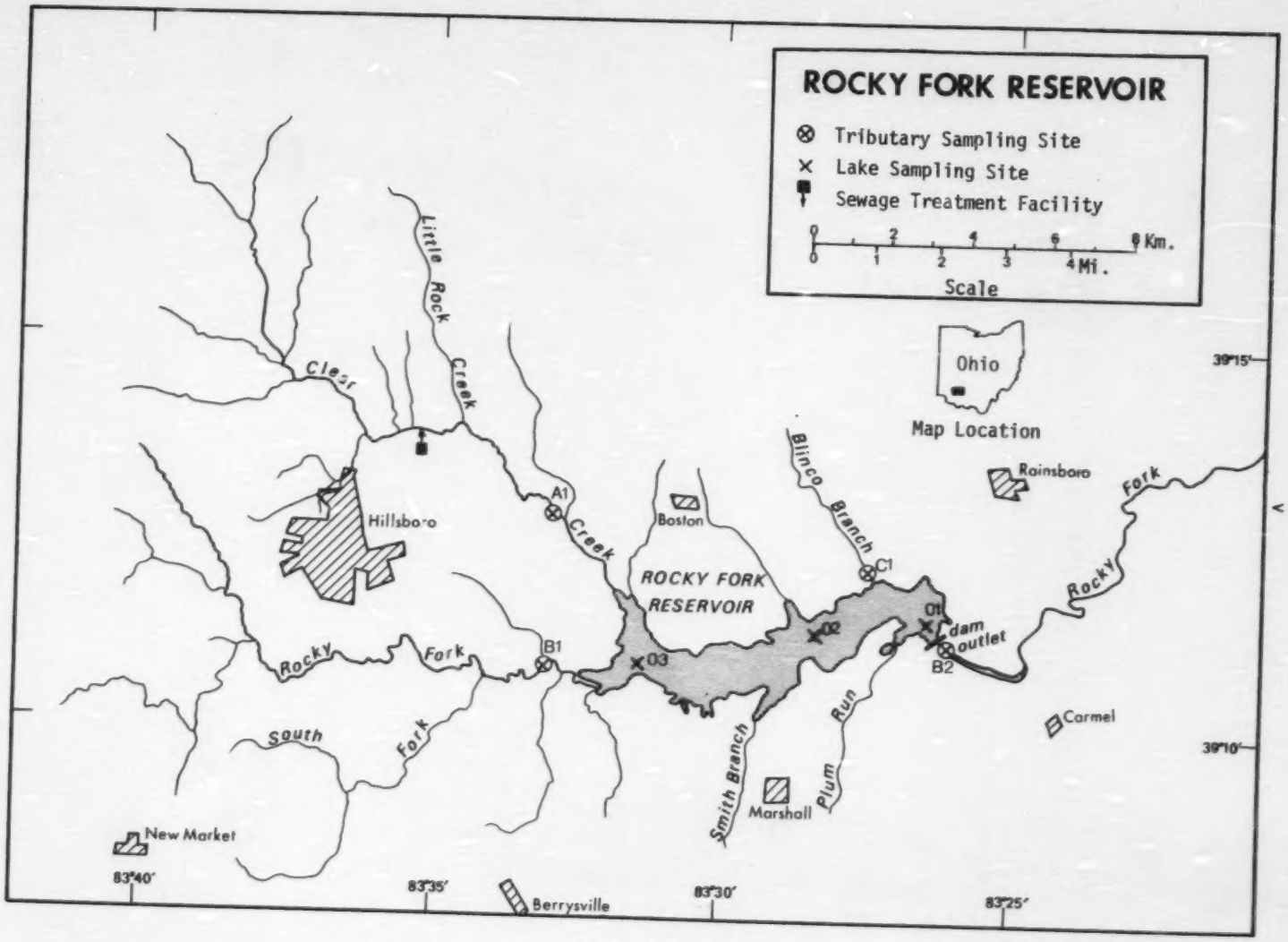
Major General Dana L. Stewart, then the Adjutant General of Ohio, and Project Officer Lt. Colonel Robert C. Timmons, who directed the volunteer efforts of the Ohio National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF OHIO

LAKE NAME	COUNTY
Atwood	Carroll, Tuscarawas
Beach City	Stark, Tuscarawas
Berlin	Mahoning, Portage, Stark
Buckeye	Fairfield, Licking, Perry
Charles Mill	Ashland, Richland
Deer Creek	Fayette, Pickaway
Delaware	Delaware
Dillon	Muskingum
Grand Lake of St. Marys	Auglaize, Mercer
Grant	Brown
Holiday	Huron
Hoover	Delaware, Franklin
Indian	Logan
Loramie	Auglaize, Shelby
Mosquito Creek	Trumbull
O'Shaughnessy	Delaware
Pymatuning	Ashtabula, OH; Crawford, PA
Pleasant Hill	Ashland, Richland
Rocky Fork	Highland
Shawnee	Greene
Tappan	Harrison


ROCKY FORK RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
0 2 4 6 8 Km.
0 1 2 3 4 Mi.
Scale
Ohio
Map Location
Little Rock Creek
Clear
Hillsboro
A1
Creek
Boston
ROCKY FORK RESERVOIR
Blinco Branch
C1
Rainsboro
Rocky Fork
O1
dam outlet
B2
O2
O3
B1
Rocky Fork
South Fork
Smith Branch
Plum Run
Marshall
Carmel
New Market
Berrysville
39°15'
39°10'
83°40'
83°35'
83°30'
83°25'

ROCKY FORK RESERVOIR

STORET NO. 3932

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Rocky Fork Reservoir is eutrophic. The reservoir ranked eighth when the 20 Ohio lakes sampled in 1973 were compared using a combination of six lake parameters*. Six of the lakes had less median total phosphorus, six had less median dissolved phosphorus, ten had less median inorganic nitrogen, ten had less mean chlorophyll a, and eight had greater mean Secchi disc transparency. Dissolved oxygen was markedly depressed or depleted in all samples taken at 4.6 meters or deeper in August and October, 1973.

Survey limnologists noted concentrations of algae at all stations in April.

B. Rate-Limiting Nutrient:

The algal assay results indicate phosphorus limitation at the time the sample was taken (04/28/73). The lake data indicate phosphorus limitation at the other sampling times as well.

C. Nutrient Controllability:

1. Point sources--The phosphorus load from the Hillsboro wastewater treatment plant amounted to 30.8% of the total reaching the reservoir during the sampling year. Six smaller point sources collectively contributed less than 1% of the total load.

The present loading of 2.05 $g/m^2/yr$ is almost three times

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* See Appendix A.

that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 12). A reduction of 10,930 kg/yr in the total load is needed to reach the eutrophic loading of 0.7 $g/m^2/yr$. Although a reduction of that magnitude is not possible at the Hillsboro treatment plant and the six small point sources, the reservoir is phosphorus limited, and a high degree of point-source phosphorus control should improve the water quality of the reservoir.

2. Non-point sources--The phosphorus contribution of non-point sources amounted to 68.4% of the total load. Of the gaged tributaries, Clear Creek contributed 42.9%; Rocky Fork, 7.4%; and Blinco Branch, 3.2%. The ungaged drainage area was estimated to have contributed 14.0% of the total.

The non-point phosphorus export rate of the Clear Creek drainage area was considerably higher than the rates of the other gaged tributaries (see page 12). This may have resulted from an underestimation of the phosphorus load from the Hillsboro treatment plant or other point sources discharging to this creek. In any case, a reduction of the phosphorus export of Clear Creek would reduce the total phosphorus loading to Rocky Fork Reservoir.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 8.17 kilometers^2.

2. Mean depth: 5.1 meters.

3. Maximum depth: >12.1 meters.

4. Volume: 41.667 x 10^6 m^3.

5. Mean hydraulic retention time: 142 days.

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Rocky Fork (B-1)	86.5	1.0
Clear Creek	91.7	1.0
Blinco Branch	15.2	0.2
Minor tributaries & immediate drainage -	93.3	1.2
Total	287.2	3.4

2. Outlet -

Rocky Fork (B-2)	295.3**	3.4

C. Precipitation***:

1. Year of sampling: 127.5 centimeters.

2. Mean annual: 111.1 centimeters.

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† Table of metric equivalents--Appendix B.
†† Youger, 1975.
* For limits of accuracy, See Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Rocky Fork Reservoir was sampled three times during the open-water season of 1973 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three stations on the lake and from a number of depths at each station (see map, page v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 12.2 meters at station 1, 6.7 meters at station 2, and 1.5 meters at station 3.

The lake sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR ROCKY FORK LAKE
STORET CODE 3932

PARAMETER	1ST SAMPLING (4/28/73) 3 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (8/ 1/73) 3 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (10/ 9/73) 3 SITES RANGE	MEAN	MEDIAN
TEMP (C)	10.7 - 13.0	12.5	12.8	15.9 - 26.7	23.3	25.4	17.1 - 22.3	21.1	21.6
DISS OXY (MG/L)	8.8 - 11.7	9.9	9.9	0.0 - 8.5	2.8	1.2	0.0 - 12.4	4.2	3.8
CNDCTVY (MCROMO)	300. - 410.	359.	375.	340. - 367.	351.	350.	315. - 396.	333.	324.
PH (STAND UNITS)	8.2 - 8.5	8.4	8.5	7.2 - 8.9	7.9	7.7	7.1 - 9.0	7.9	7.9
TOT ALK (MG/L)	123. - 166.	154.	164.	144. - 192.	159.	154.	150. - 218.	160.	151.
TOT P (MG/L)	0.055 - 0.231	0.103	0.068	0.044 - 0.182	0.077	0.063	0.051 - 0.285	0.092	0.066
ORTHO P (MG/L)	0.003 - 0.040	0.013	0.006	0.006 - 0.013	0.008	0.008	0.009 - 0.017	0.012	0.012
NO2+NO3 (MG/L)	0.670 - 0.960	0.771	0.740	0.080 - 0.330	0.128	0.110	0.030 - 0.170	0.054	0.040
AMMONIA (MG/L)	0.060 - 0.160	0.090	0.080	0.070 - 2.060	0.515	0.180	0.060 - 6.350	0.957	0.210
KJEL N (MG/L)	0.500 - 1.100	0.742	0.700	0.500 - 3.900	1.282	0.900	0.800 - 8.700	1.960	1.050
INORG N (MG/L)	0.790 - 1.090	0.861	0.830	0.150 - 2.160	0.644	0.340	0.100 - 6.430	1.011	0.240
TOTAL N (MG/L)	1.230 - 1.860	1.512	1.445	0.590 - 4.030	1.410	1.010	0.830 - 8.780	2.014	1.135
CHLRPYL A (UG/L)	6.9 - 80.9	54.1	74.4	39.5 - 46.0	42.4	41.6	5.7 - 25.9	17.6	21.3
SECCHI (METERS)	0.2 - 0.7	0.5	0.6	0.5 - 0.9	0.7	0.9	0.6 - 0.9	0.8	0.9

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/28/73	1. *Melosira sp.*	24,595
	2. *Stephanodiscus sp.*	8,268
	3. *Cryptomonas sp.*	1,459
	4. Flagellates	625
	5. *Euglena sp.*	347
	Other genera	625
	Total	35,919
08/01/73	1. *Oscillatoria sp.*	3,639
	2. *Dactylococcopsis sp.*	676
	3. *Cryptomonas sp.*	466
	4. *Merismopedia sp.*	280
	5. Centric diatoms	280
	Other genera	793
	Total	6,134
10/09/73	1. *Lyngbya sp.*	7,381
	2. *Oscillatoria sp.*	6,250
	3. *Nitzschia sp.*	3,512
	4. *Raphidiopsis sp.*	2,917
	5. *Merismopedia sp.*	2,024
	Other genera	7,499
	Total	29,583

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (μg/l)
04/28/73	01	74.4
	02	80.9
	03	6.9
08/01/73	01	41.6
	02	39.5
	03	46.0
10/09/73	01	21.3
	02	25.9
	03	5.7

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.016	0.838	2.5
0.050 P	0.066	0.838	17.5
0.050 P + 1.0 N	0.066	1.838	19.0
1.0 N	0.016	1.838	4.6

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Rocky Fork Lake was moderately high at the time the sample was collected (04/28/73). A significant increase in yield occurred when phosphorus was added alone and in combination with nitrogen. The increase in yield when only nitrogen was added is not considered significant as compared to that of the control.

The lake data indicate phosphorus limitation at all sampling times (the mean inorganic nitrogen/orthophoshorus ratios were 66/1 or greater, and phosphorus limitation would be expected).

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Ohio National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff month of March when three samples were collected. Sampling was begun in May, 1973, and was completed in April, 1974.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Ohio District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loads shown are those measured minus point-source loads, if any.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the means of the nutrient loads, in $kg/km^2/year$, at stations B-1 and C-1 and multiplying the means by the ZZ area in km^2.

The operator of the Hillsboro wastewater treatment plant provided monthly effluent samples and corresponding flow data. The operators of the treatment plants serving Rocky Fork State Park, Pleasant Acres Mobile Home Park, and Rocky Fork Marine Sales and Service did not

* See Working Paper No. 175.

participate in the Survey, and nutrient loads were estimated at 1.134 kg P and 3.401 kg N/capita/year.

A. Waste Sources:

1. Known municipal† -

Name	Pop. Served	Treatment	Mean Flow (m^3/d)	Receiving Water
Hillsboro	6,000	act. sludge	2,633.2	Clear Creek
Rocky Fork State Park #1	450*	ext. aer.	170.3**	Rocky Fork Res.
#2	240*	ext. aer.	90.8**	Churn Cr. arm of reservoir
#3	240*	ext. aer.	90.8**	Plum Run arm of reservoir
#4	50*	ext. aer.	18.9**	Smith Branch arm of reservoir
Pleasant Acres MHP	75*	ext. aer.	28.4**	Unnamed trib to Rocky Fork Cr.
Rocky Fork Marine Sales & Serv.	200*	ext. aer.	75.7**	Churn Cr. arm of reservoir

2. Known industrial - None

† Hennison, 1974; Youger, 1975.
* Estimated from flows (0.3785 m^3/capita/day).
** Design flows.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Rocky Fork	1,245	7.4
Clear Creek	7,200	42.9
Blinco Branch	540	3.2
b. Minor tributaries & immediate drainage (non-point load) -	2,345	14.0
c. Known domestic STP's -		
Hillsboro	5,165	30.8
Rocky Fork State Park		
#1	50	0.3
#2	25	0.1
#3	25	0.1
#4	5	<0.1
Pleasant Acres MHP	10	<0.1
Rocky Fork Marine Sales & Serv.	25	0.1
d. Septic tanks - Unknown	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	145	0.9
Total	16,780	100.0

2. Outputs -

Lake outlet - Rocky Fork 4,945

3. Net annual P accumulation - 11,835 kg.

* See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/ yr	% of total
a. Tributaries (non-point load) -		
Rocky Fork	67,470	25.6
Clear Creek	76,955	29.2
Blinco Branch	14,300	5.4
b. Minor tributaries & immediate drainage (non-point load) -	80,620	30.6
c. Known domestic STP's -		
Hillsboro	11,230	4.3
Rocky Fork State Park		
#1	1,530	0.6
#2	815	0.3
#3	815	0.3
#4	170	<0.1
Pleasant Acres MHP	255	0.1
Rocky Fork Marine Sales & Serv.	680	0.3
d. Septic tanks - Unknown	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	8,820	3.3
Total	263,660	100.0

2. Outputs -

Lake outlet 188,435

3. Net annual N accumulation - 75,225 kg.

* See Working Paper No. 175.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Rocky Fork	14	780
Clear Creek	79	839
Blinco Branch	36	941

E. Yearly Loadings:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	2.05	1.45	32.3	9.2

Vollenweider phosphorus loadings (g/m^2/yr) based on mean depth and mean hydraulic retention time of Rocky Fork Reservoir:

"Dangerous" (eutrophic loading)	0.70
"Permissible" (oligotrophic loading)	0.35

V. LITERATURE REVIEWED

Hennison, Ronald N., 1974. Treatment plant questionnaire (Hillsboro STP). Hillsboro.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

Youger, John, 1975. Personal communication (lake morphometry; point sources). OH Env. Prot. Agency, Columbus.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
3901	BEACH CITY RESERVOIR	0.122	1.990	489.000	10.867	11.600	0.015
3902	BUCKEYE LAKE	0.179	0.380	490.000	186.567	9.600	0.020
3905	CHARLES MILL RESERVOIR	0.127	0.465	482.555	67.144	15.000	0.011
3906	DEER CREEK RESERVOIR	0.098	2.980	470.125	9.887	13.900	0.036
3907	DELAWARE RESERVOIR	0.086	2.340	484.111	10.856	14.500	0.024
3908	DILLION RESERVOIR	0.163	1.590	481.250	27.400	14.300	0.037
3912	GRANT LAKE	0.113	0.570	486.333	40.533	12.200	0.019
3914	HOOVER RESERVOIR	0.040	1.640	462.750	13.017	14.800	0.008
3915	INDIAN LAKE	0.120	0.380	485.222	76.855	14.200	0.012
3917	LORAMIE LAKE	0.185	1.380	494.000	104.100	8.200	0.019
3921	MOSQUITO CREEK RESERVOIR	0.058	0.150	465.333	36.267	11.600	0.006
3924	PLEASANT HILL LAKE	0.036	0.455	456.833	22.850	14.700	0.010
3927	LAKE SAINT MARYS	0.148	0.200	484.167	79.150	8.200	0.014
3928	ATWOOD RESERVOIR	0.031	0.205	462.000	16.442	14.700	0.005
3929	BERLIN RESERVOIR	0.042	0.900	465.435	15.496	13.600	0.006
3930	HOLIDAY LAKE	0.125	0.575	465.333	55.350	15.000	0.034
3931	O'SHAUGNESSY RESERVOIR	0.208	3.070	479.333	5.522	14.900	0.159
3932	ROCKY FORK LAKE	0.067	0.790	473.000	38.022	15.000	0.010
3933	SHAWNEE LAKE	0.069	2.380	474.333	39.567	15.000	0.009
3934	TAPPAN LAKE	0.040	0.280	466.111	37.711	15.000	0.007

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
3901	BEACH CITY RESERVOIR	37 (7)	21 (4)	11 (2)	84 (16)	82 (15)	42 (8)	277
3902	BUCKEYE LAKE	11 (2)	76 (14)	5 (1)	0 (0)	89 (17)	26 (5)	207
3905	CHARLES MILL RESERVOIR	26 (5)	63 (12)	37 (7)	21 (4)	11 (0)	58 (11)	216
3906	DEER CREEK RESERVOIR	53 (10)	5 (1)	63 (12)	95 (18)	63 (12)	11 (2)	290
3907	DELAWARE RESERVOIR	58 (11)	16 (3)	32 (6)	89 (17)	47 (9)	21 (4)	263
3908	DILLION RESERVOIR	16 (3)	32 (6)	42 (8)	58 (11)	53 (10)	5 (1)	206
3912	GRANT LAKE	47 (9)	58 (11)	16 (3)	32 (6)	74 (14)	34 (6)	261
3914	HOOVER RESERVOIR	87 (16)	26 (5)	89 (17)	79 (15)	32 (6)	79 (15)	392
3915	INDIAN LAKE	42 (8)	76 (14)	21 (4)	16 (3)	58 (11)	53 (10)	266
3917	LORAMIE LAKE	5 (1)	37 (7)	0 (0)	5 (1)	97 (18)	34 (6)	178
3921	MOSQUITO CREEK RESERVOIR	74 (14)	100 (19)	82 (15)	53 (10)	82 (15)	92 (17)	483
3924	PLEASANT HILL LAKE	95 (18)	68 (13)	100 (19)	63 (12)	39 (7)	66 (12)	431
3927	LAKE SAINT MARYS	21 (4)	95 (18)	26 (5)	11 (2)	97 (18)	47 (9)	297
3928	ATWOOD RESERVOIR	100 (19)	89 (17)	95 (18)	68 (13)	39 (7)	100 (19)	491
3929	BERLIN RESERVOIR	79 (15)	42 (8)	74 (14)	74 (14)	68 (13)	92 (17)	429
3930	HOLIDAY LAKE	32 (6)	53 (10)	82 (15)	26 (5)	11 (0)	16 (3)	220
3931	O'SHAUGNESSY RESERVOIR	0 (0)	0 (0)	47 (9)	100 (19)	26 (5)	0 (0)	173
3932	ROCKY FORK LAKE	68 (13)	47 (9)	58 (11)	42 (8)	11 (0)	66 (12)	292
3933	SHAWNEE LAKE	63 (12)	11 (2)	53 (10)	37 (7)	11 (0)	74 (14)	249
3934	TAPPAN LAKE	87 (16)	84 (16)	68 (13)	47 (9)	11 (0)	84 (16)	381

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	3928	ATWOOD RESERVOIR	491
2	3921	MOSQUITO CREEK RESERVOIR	483
3	3924	PLEASANT HILL LAKE	431
4	3929	BERLIN RESERVOIR	429
5	3914	HOOVER RESERVOIR	392
6	3934	TAPPAN LAKE	381
7	3927	LAKE SAINT MARYS	297
8	3932	ROCKY FORK LAKE	292
9	3906	DEER CREEK RESERVOIR	290
10	3901	BEACH CITY RESERVOIR	277
11	3915	INDIAN LAKE	266
12	3907	DELAWARE RESERVOIR	263
13	3912	GRANT LAKE	261
14	3933	SHAWNEE LAKE	249
15	3930	HOLIDAY LAKE	220
16	3905	CHARLES MILL RESERVOIR	216
17	3902	BUCKEYE LAKE	207
18	3908	DILLION RESERVOIR	206
19	3917	LORAMIE LAKE	178
20	3931	O'SHAUGNESSY RESERVOIR	173

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR OHIO 1/27/75

LAKE CODE 3932 ROCKY FORK LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 295.3

NORMALIZED FLOWS(CMS)

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
3932A1	91.7	1.90	2.27	2.24	1.81	1.05	0.62	0.40	0.40	0.27	0.18	0.54	1.08	1.05
3932B1	86.5	1.81	2.18	2.12	1.70	0.99	0.57	0.37	0.37	0.26	0.16	0.51	1.05	1.00
3932B2	295.3	6.09	7.31	7.25	5.83	3.40	1.95	1.25	1.25	0.85	0.57	1.73	3.51	3.39
3932C1	15.2	0.31	0.37	0.40	0.31	0.18	0.10	0.06	0.06	0.04	0.03	0.08	0.18	0.17
3932ZZ	102.0	2.07	2.49	2.49	2.01	1.19	0.68	0.42	0.42	0.28	0.20	0.59	1.22	1.17

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 295.3
SUM OF SUB-DRAINAGE AREAS = 295.4

TOTAL FLOW IN = 41.00
TOTAL FLOW OUT = 40.97

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3932A1	5	73	1.30	5	0.82				
	6	73	1.19	16	2.12				
	7	73	1.19	14	0.62				
	8	73	0.57	18	0.27				
	9	73	0.19	15	0.17				
	10	73	0.45	20	0.21				
	11	73	2.10	17	0.65				
	12	73	1.50	15	0.85				
	1	74	2.63	12	1.78				
	2	74	1.30	16	0.96				
	3	74	1.87	2	3.11	16	6.82	30	5.72
	4	74	1.56	13	1.05				
3932B1	5	73	1.22	5	0.79				
	6	73	1.08	16	2.04				
	7	73	1.10	14	0.59				
	8	73	0.54	18	0.25				
	9	73	0.18	15	0.16				
	10	73	0.42	20	0.20				
	11	73	1.98	17	0.62				
	12	73	1.44	15	0.79				
	1	74	2.52	12	1.70				
	2	74	1.25	16	0.91				
	3	74	1.78	2	2.94	16	6.46	30	5.41
	4	74	1.44	13	0.99				

TRIBUTARY FLOW INFORMATION FOR OHIO 1/27/75

LAKE CODE 3932 ROCKY FORK LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
393282	5	73	4.11	5	4.87				
	6	73	3.45	16	1.56				
	7	73	3.94	14	1.67				
	8	73	2.21	18	2.78				
	9	73	0.57	15	0.45				
	10	73	1.64	20	0.37				
	11	73	5.80	17	3.09				
	12	73	5.24	15	3.00				
	1	74	8.58	12	11.58				
	2	74	4.53	16	3.09				
	3	74	5.66	2	4.56	16	10.93	30	8.21
	4	74	5.66	13	5.69				
3932C1	5	73	0.22	5	0.14				
	6	73	0.18	16	0.34				
	7	73	0.18	14	0.10				
	8	73	0.08	18	0.05				
	9	73	0.02	15	0.03				
	10	73	0.07	20	0.03				
	11	73	0.31	17	0.11				
	12	73	0.24	15	0.14				
	1	74	0.42	12	0.28				
	2	74	0.21	16	0.16				
	3	74	0.34	2	0.51	16	1.13	30	0.93
	4	74	0.27	13	0.18				
393277	5	73	1.47						
	6	73	1.30						
	7	73	1.27						
	8	73	0.62						
	9	73	0.20						
	10	73	0.51						
	11	73	2.32						
	12	73	1.67						
	1	74	2.86						
	2	74	1.42						
	3	74	2.10						
	4	74	1.73						

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 75/01/27

393201
39 11 15.0 083 26 31.0
MUCKY FORK LAKE
39071 OHIO

ITEMALES
3

2111202
0043 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CONDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/28	09 35	0000	12.8		28	380	8.50	164	0.060	0.700	0.730	0.007
	09 35	0006	12.8	10.0		370	8.50	164	0.070	0.700	0.730	0.010
	09 35	0015	12.8	10.0		380	8.50	165	0.060	0.500	0.730	0.005
	09 35	0022	12.8	10.0		410	8.20	166	0.070	0.500	0.740	0.003
	09 35	0030	12.7	9.8		360	8.50	161	0.080	0.700	0.750	0.005
	09 35	0039	12.1	6.0		300	8.40	123	0.160	1.100	0.670	0.021
73/08/01	15 45	0000	26.7	8.3	34	343	8.80	147	0.090	0.900	0.110	0.007
	15 45	0005	26.3			340						
	15 45	0010	26.0			340						
	15 45	0015	25.6	1.4		350	7.70	144	0.110	0.500	0.090	0.010
	15 45	0020	24.1	1.1		357	7.30	156	0.560	1.100	0.120	0.011
	15 45	0025	19.4			347						
	15 45	0030	16.6	0.3		348	7.20	192	2.060	2.500	0.100	0.007
	15 45	0035	16.0			352						
	15 45	0040	15.9	0.0		356	7.30	184	1.220	3.900	0.130	0.009
73/10/09	13 25	0000	22.3		36	324	8.50	150	0.130	1.300	0.040	0.012
	13 25	0005	21.7	5.2		323	8.00	152	0.200	0.800	0.030	0.012
	13 25	0015	21.5	2.6		324	7.70	151	0.310	1.000	0.030	0.012
	13 25	0025	20.6	0.0		356	7.40	170	1.650	2.800	0.050	0.015
	13 25	0034	17.1	0.0		396	7.10	218	6.350	8.700	0.080	0.017

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/28	09 35	0000	0.055	74.4
	09 35	0006	0.056	
	09 35	0015	0.060	
	09 35	0022	0.060	
	09 35	0030	0.095	
	09 35	0039	0.197	
73/08/01	15 45	0000	0.055	41.6
	15 45	0015	0.056	
	15 45	0020	0.068	
	15 45	0030	0.092	
	15 45	0040	0.096	
73/10/09	13 25	0000	0.057	21.3
	13 25	0005	0.053	
	13 25	0015	0.059	
	13 25	0025	0.086	
	13 25	0034	0.285	

STORET RETRIEVAL DATE 75/01/27

393202
39 11 17.0 083 28 26.0
ROCKY FORK LAKE
39071 OHIO

11EPALES 2111202
3 0026 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/28	10 10	0000	13.0		24	375	8.30	166	0.080	0.900	0.750	0.012
	10 10	0006	13.0	11.7		380	8.50	164	0.080	0.600	0.760	0.005
	10 10	0015	13.0	9.6		380	8.50	166	0.070	0.700	0.740	0.004
	10 10	0022	13.0	9.6		375	8.50	165	0.090	0.800	0.740	0.004
73/08/01	15 15	0000	26.6		36	345	8.80	147	0.080	0.600	0.090	0.006
	15 15	0005	26.2	8.5		347	8.60	146	0.070	0.600	0.080	0.007
	15 15	0010	26.0			358						
	15 15	0015	25.3	1.2		367	7.50	161	0.200	0.700	0.140	0.008
	15 15	0020	22.5	0.3		360	7.40	171	1.010	1.600	0.100	0.006
73/10/09	13 50	0000	22.1		35	321	8.10	150	0.170	0.800	0.040	0.013
	13 50	0005	21.7	5.6		322	7.90	151	0.190	1.000	0.030	0.011
	13 50	0015	21.7	4.6		324	7.90	151	0.220	0.900	0.030	0.009
	13 50	0021	20.9	3.0		327	7.70	154	0.290	1.100	0.170	0.011

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/28	10 10	0000	0.066	80.9
	10 10	0006	0.067	
	10 10	0015	0.069	
	10 10	0022	0.072	
73/08/01	15 15	0000	0.045	39.5
	15 15	0005	0.044	
	15 15	0015	0.060	
	15 15	0020	0.063	
73/10/09	13 50	0000	0.066	25.9
	13 50	0005	0.055	
	13 50	0015	0.051	
	13 50	0021	0.096	

STORET RETRIEVAL DATE 75/01/27

393203
39 10 51.0 083 31 23.0
ROCKY FORK LAKE
39071 OHIO

11EPALES 2111202
3 0009 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/28	10 45	0000	10.8		8	300	8.20	124	0.130	0.800	0.950	0.040
	10 45	0005	10.7	9.9		300	8.20	123	0.130	0.900	0.960	0.038
73/08/01	15 00	0000	26.2		18	350	8.90	147	0.090	0.800	0.120	0.008
	15 00	0005	23.6	4.4		358	7.80	154	0.180	0.900	0.330	0.013
73/10/09	15 00	0000	21.5	12.4	24	315	9.00	150	0.060	1.200	0.040	0.012

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/28	10 45	0000	0.231	6.9
	10 45	0005	0.212	
73/08/01	15 00	0000	0.085	46.0
	15 00	0005	0.182	
73/10/09	15 00	0000	0.100	5.7

APPENDIX E

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 75/02/03

3932A1
39 12 46.0 083 33 00.0
CLEAR CREEK
39041 7.5 HILLSBORO
T/ROCKY FORK RESERVOIR
US 50 BRDG 3.2 MI ENE OF HILLSBORO
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/05/05	15 00		1.720	1.200	0.189	0.130	0.150
73/06/16	09 40		2.060	1.150	0.140	0.005K	0.375
73/07/14	10 30		1.900	1.150	0.189	0.480	0.535
73/08/18	09 25		1.920		0.310	0.680	0.780
73/09/15	09 17		1.960	0.230	0.061	0.063	
73/10/20	10 50		1.900	1.050	0.132	0.770	0.790
73/11/17	09 00		0.990	1.300	0.148	0.384	0.440
73/12/15	14 45		1.600	0.300	0.096	0.148	0.180
74/01/12	15 35		1.680	0.400	0.044	0.076	0.105
74/02/16	10 30		1.700	0.650	0.150	0.220	0.265
74/03/02	13 10		1.360	1.200	0.035	0.052	0.240
74/03/16	10 00		1.340	1.700	0.045	0.065	0.375
74/03/30	12 50		1.260	1.800	0.070	0.085	0.460
74/04/13	09 30		1.600	0.400	0.060	0.110	0.110

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/03

393281
39 10 45.0 083 33 05.0
ROCKY FORK
39 7.5 HILLSBORO
1/ROCKY FORK RESERVOIR
2NDRY RD BRDG 3.2 MI ESE OF HILLSBORO
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/05/05	13 37		0.690	2.200	0.070	0.008	0.015
73/06/16	08 40		0.660	3.400	0.054	0.023	0.049
73/07/14	09 40		0.690	0.720	0.052	0.058	0.080
73/09/15	08 37		0.520	0.100K	0.019	0.020	0.042
73/10/20	09 50		0.252	1.450	0.044	0.010	0.015
73/11/17	10 30		0.810	0.600	0.028	0.036	0.060
73/12/15	13 50		0.900	0.300	0.016	0.016	0.035
74/01/12	14 05		0.950	0.400	0.020	0.020	0.035
74/02/16	09 15		0.820	1.100	0.020	0.010	0.015
74/03/02	11 15		0.840	2.350	0.030	0.015	0.058
74/03/16	09 00		0.910	1.700	0.035	0.040	0.043
74/03/30	12 05		0.616	3.200	0.103	0.030	0.037
74/04/13	08 45		0.660	0.200	0.015	0.010	0.025

K VALUE KNOW TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/03

393282
39 10 59.0 083 26 10.0
ROCKY FORK
39 7.5 RAINBORO
0/ROCKY FORK RESERVOIR
2NDRY RD BRDG .2 MI BELO DAM
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/05/05	14	10	0.650	1.980	0.081	0.005K	0.065
73/06/16	09	00	0.176	1.720	0.105	0.005K	0.035
73/07/14	10	00	0.023	3.500	0.059	0.013	0.045
73/08/18	08	55	0.010K	1.050	0.028	0.009	0.035
73/09/15	08	50	0.198	0.750	0.280	0.015	0.045
73/10/20	10	07	0.220	1.300	0.310	0.009	0.045
73/11/17	10	00	0.192	1.150	0.240	0.016	0.035
73/12/15	14	15	0.480	1.000	0.216	0.024	0.057
74/01/12	14	30	0.720	0.600	0.136	0.032	0.070
74/02/16	09	45	0.950	1.400	0.020	0.005	0.055
74/03/02	11	30	0.830	0.800	0.010	0.005	0.075
74/03/16	09	15	0.770	0.800	0.045	0.010	0.032
74/03/30	12	17	0.730	0.700	0.025	0.010	0.045
74/04/13	09	00	0.660	0.500	0.030	0.005	0.005

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/03

3932C1
39 12 00.0 083 27 31.0
BLINCO BRANCH
39 7.5 RAINBORO
1/ROCKY FORK RESERVOIR
2NDRY RD BRDG AT MOUTH
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/05/05	14 30		2.080	1.320	0.027	0.007	0.025
73/06/16	09 20		0.590	1.540	0.110	0.008	0.080
73/07/14	10 15		0.168	2.900	0.072	0.011	0.080
73/08/18	09 10		0.280	2.200	0.056	0.013	0.070
73/09/15	09 00		0.069	0.500	0.075	0.005K	0.060
73/10/20	10 20		0.088	1.150	0.270	0.007	0.040
73/11/17	09 30		0.890	0.900	0.084	0.060	0.130
73/12/15	14 30		2.000	0.500	0.024	0.024	0.040
74/01/12	14 45		2.400	0.900	0.052	0.028	0.040
74/02/16	09 30		2.200	0.500	0.010	0.010	0.020
74/03/02	11 50		1.700	1.300	0.025	0.040	0.250
74/03/16	09 30		1.920	1.400	0.100	0.140	0.350
74/03/30	12 34		2.100	1.200	0.030	0.040	0.175
74/04/13	09 15		2.000	0.200	0.005	0.010	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/03

3432AA A53432AA P006000
39 13 32.0 083 35 15.0
MILLSBORO
39041 7.5 MILLSBORO
T/ROCKY FORK RESERVOIR
CLEAR CREEK
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 N02&N03 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/08/30	11 00								
CP(T)-			0.168	18.900	8.000	4.200	5.950	0.643	0.678
73/08/30	15 00								
73/10/03	09 00								
CP(T)-			0.540	10.500		4.500	7.000	0.922	0.481
73/10/03	16 00								
73/10/31	09 30								
CP(T)-			0.050	16.000	3.740	4.500	5.250	0.819	0.586
73/10/31	14 30								
73/11/30	10 30								
CP(T)-			1.800	9.700	0.140	2.900	4.400	1.200	0.723
73/11/30	16 00								
73/12/31	09 30								
CP(T)-			1.280	8.700	0.088	3.200	5.400	0.967	0.847
73/12/31	15 00								
74/01/30	09 30								
CP(T)-			0.080	7.400		3.360	4.400	1.020	1.070
74/01/30	15 30								
74/02/28	09 30		0.840	9.250	0.480	4.800	5.800	0.709	0.741
74/03/30	09 30								
CP(T)-			1.840	1.000K	0.050K	1.650	2.000	1.200	0.898
74/03/30	16 00								
74/04/30	09 00								
CP(T)-			0.280	13.000	2.500	9.500	11.500	0.580	0.748
74/04/30	15 00								
74/05/30	09 30								
CP(T)-			0.080	13.000	1.700	3.600	4.400	0.825	0.623
74/05/30	15 30								
74/06/30	09 30								
CP(T)-			0.120	19.000	7.700	7.700	8.900	0.480	0.652
74/06/30	16 00								
74/07/30	09 30								
CP(T)-			0.076	19.000	5.450	7.400	8.800	0.399	0.501
74/07/30	15 30								
74/08/31	10 30								
CP(T)-			4.300	8.750	0.140	2.750	3.880	1.140	0.495
74/08/31	15 30								

K VALUE KNOWN TO BE
LESS THAN INDICATED

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